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ON THE INFLUENCE OF ATMOSPHERIC CHANGES UPON DISEASE.

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X.—*On the Influence of Atmospheric Changes upon Disease.*

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Read April 17th, 1860.

Two hundred years ago the remark was made to Sydenham,* and the statement holds true now, that "no physician hitherto has attentively considered the force and influence of the atmosphere upon human bodies; nor yet has he sufficiently ascertained the part it plays in prolonging human life."

From very early ages men have observed that certain diseases prevail most during certain seasons, and have ascribed to atmospheric changes an important influence upon health, but, until recently, no solid foundation of accurately observed facts had been laid.

Most of the old medical writers deal with the subject—some of them very carefully. Hippocrates devoted one of his works to "Airs, Waters and Places;" and his writings upon epidemics, and his aphorisms, abound with remarks on the influence of various states of the air upon the human frame. Since his time many others have very fully noticed the coincidence between these phenomena, as

* Letter to Dr. Sydenham, from Dr. Thos. Brady. — *Sydenham Society's Transactions*, vol. ii. p. 1.

Aretæus,* Sydenham,† Boerhaave,‡ Vitet, Ramazzini.§ Baglivi,‖ and more modern authors. Still, owing perhaps to the imperceptible and apparently mysterious way in which atmospheric changes take place, and more to the necessity for well organized and simultaneous observations in both branches of the inquiry, little further progress towards a true science of medical meteorology has been made until lately. The first attempt upon a comprehensive plan to advance this subject was made in January 1844, by adding meteorological tables, furnished by the Astronomer Royal, to the weekly returns of the Registrar General, these returns being for London only. Somewhat later, monthly returns were obtained from stations in different parts of England, and appended to the quarterly returns of the Registrar General; and from the year 1849 these stations have gradually increased in number, and at the present time there are about sixty in England and Wales. Similar returns from about forty-five stations are now added to the monthly and quarterly returns of the Registrar General for Scotland.

Some years after these returns were commenced, it was thought that more useful information might be obtained by similar comparisons with respect to disease; and in 1853 an attempt was made by some members of the Provincial Medical Association to compare meteorological tables for different places, with the diseases prevalent in those districts, but unfortunately these records were not continued for more than two years and a quarter.

In 1857 the General Board of Health in London took up this question; and from the week ending April 11*th*

* περι Αἵματος Ἀναγωγῆς.

† *Observationum Medicarum.*

‡ *Causes of Disease.*

§ *De principium valetudine tuenda,* cap. iii.

‖ *De æris influxibus investigandis ac perdiscendis, ad morbos dignoscendos et curandos.*

1857, to the week ending November 6*th* 1858, they published a carefully compiled weekly return of new cases of disease in London, furnished by the voluntary efforts of upwards of two hundred gentlemen connected with the medical profession. The tables are accompanied by meteorological observations made at six stations in and out of London, and although not perfectly accurate, yet they are of great value; it is much to be regretted that they were carried on for so short a period.

Hitherto careful collation of the two classes of facts recorded in these tables seems to have been wanting; and in the present paper we have endeavoured to supply the deficiency, and to deduce from the comparison some general conclusions.

We must here state that our inquiry originated in some investigations which were made for the Manchester and Salford Sanitary Association by a committee consisting of Messrs. Curtis, Ransome and Vernon.

The method we have employed in making the necessary comparisons of the two series of observations has been as follows:

1*st*. We have projected the medical and meteorological returns upon separate charts, so as to form curves, which represent the prevalence of the disease or the state of the atmosphere at any particular time; and then, by comparing the two charts, and noticing any evident coincidences, we have been led to the conclusions specified in the paper, respecting the following diseases: Diarrhœa, dysentery, pneumonia, bronchitis and catarrh, pleurisy, continued fever, rheumatic fever, measles, whooping cough, and scarlatina.

Diarrhœa.

A high mean temperature (above 60°) would seem to have a powerful influence in predisposing to this disease;

when continuous, causing a rapid increase in the number of cases.

A temperature below 60° appears to be unfavourable to its progress.

The above action is generally most evidently shown when the temperature is above or below the average of the season.

In the spring of 1857, from April 11*th* to June 20*th*, there is a gradual, and at first scarcely perceptible, rise in the diarrhœa curve, the number of cases being comparatively very small.

The temperature in April and the early part of May is much below the average (8° on May 2*nd*), although, on the whole, gradually rising.

From June 20*th* to July 11*th* the rise of the disease curve to 2,000 cases is more rapid — the temperature is above 60°, and on June 27*th* 7° above the average.

From July 18*th* to August 15*th* there is a very great increase in the number of cases (even to 5,600), but from the latter date until September 12*th* the curve sinks at nearly the *same rate* to 2,200 cases.

The number of cases then continues to diminish, but at a rather slower rate, until October 10*th*, when it is 600.

The mean temperature during the *whole of this period*, from July 18*th* to October 10*th* is above 60°, and considerably above the average, sometimes as much as 7°. In the weeks ending July 18*th* and 25*th*, it is stationary at 68° (the highest point this year), but it then gradually falls to 63·5° on August 15*th*; and after a temporary rise in the week ending August 29*th* it continues to fall until October 10*th*, thus throughout bearing a close relation to the disease.

From the week ending October 10*th* (the temperature being 1·5° below the average) the number of cases still

remains low (still diminishing as the temperature falls until January 9*th*), and it does not again rise until May 22*nd*, 1858.

In the two weeks preceding May 22*nd* 1858, the temperature is below the average as much as 6°, but it now begins rapidly to rise, and from May 29*th* to June 26*th*, 1858, it is considerably above the average (on June 5*th*, nearly 10°).

In accordance with the rise of the temperature curve the number of cases increases, and continues to increase steadily, as in the preceding year, until July 10*th*, when it is 1,200 (on July 1*st* 1857 it was 1,400).

But a remarkable difference between the two years must now be noticed, as it affords a striking illustration of proposition (*b*).

In 1857 the disease runs on after July 11*th* to an amazing prevalence, but in the present year (1858) there seems to be a sudden arrest, the number of cases remains almost stationary for a fortnight, and then slightly diminishes until August 7*th*. When we inquire into the causes of this difference, we find that whereas in 1857, from June 20*th* to September 26*th*, the mean temperature never sinks below 60°; in 1858, for the first two weeks in July, the mean temperature is below 60°; and on July 10*th* nearly 6° below the average. It seems as if the germs of the disease were so far destroyed by the unusual cold, that even the moderate warmth that follows could not again rouse them into activity.

The mean temperature in 1858 does not remain above the average, as it did in the preceding year.

From August 7*th* to August 28*th* 1858, the diarrhœa curve rises and falls with the mean temperature, but on August 28*th* the thermometer again sinks below 60°; and although it again rises in September to 63·5°, it is accompanied by no corresponding increase in the number of

eases, — the diarrhœa agent has again received a check from which it does not recover.

Dysentery

(1) Seems to be influenced by the variations in the mean temperature, but in less degree than diarrhœa, the effect not being generally traced in the lesser undulations of the curve.

(2) Increased atmospheric pressure seems to be unfavourable to the progress of the disease, high readings of the barometer being nearly always accompanied by diminished prevalence of dysentery.

The dysentery curve rises, on the whole, from the week ending April 11*th* to the week ending September 12*th*. Fostered by the unusual warmth of the season, the disease seems to gather such strength that for a fortnight after the mean temperature begins to decline, it rushes on to still greater prevalence, and reaches its highest point when the mean temperature has fallen from 68° to 60·5°.

The diminishing autumnal temperature, however, seems at length to produce an opposing influence, for the disease from this point gradually subsides, with occasional fluctuations, until the week ending January 16*th*. There is then a sudden temporary rise in the disease curve, the mean temperature being now above the average, but having been very variable in the preceding three weeks.

During February 1858, there is a rapid increase in the number of cases which is associated with a temperature very much *below* the average (as though great cold as well as great heat were favourable to the disease); but it must be noticed at the same time that the barometric reading during the month was very low.

The disease curve now falls until April 17*th*, and continues low until June 19*th* (nearly the same date as that

on which the disease took its first decided rise in the preceding year). The mean temperature has now been very high for a fortnight (from 8° to 10° above the average); and the number of cases rapidly increases until July 10*th*, when it may be noticed that the mean temperature falls suddenly to 56° (6° below the average), and the further progress of the disease is checked.

After a short rise on July 24*th* (the mean temperature having then again risen 5° above the average for the week) the dysentery curve now gradually subsides, with many fluctuations, until October 2*nd*; and it may be noticed that the most decided rise is in the week ending September 25*th*, following the unusually high temperature of the preceding week (64° or 6·5° above the average).*

Pneumonia

Seems to be very greatly influenced by the mean temperature, the disease curve rising as the temperature falls, and *vice versâ*.

The above statement receives its best illustration in the spring, summer, and autumn of the year 1857.

In the early part of the year, while the temperature remains low, the disease is still prevalent, but as the

* Hippocrates, *Aph.* 22, book iii., speaks of dysentery as an autumnal disease: "With regard to the seasons, if winter be of a dry and northerly character, and the spring rainy, and southerly, in summer there will necessarily be acute fevers, opthalmics, and dysenteries, especially in women, and in men of humid temperament." — *Aph.* 3, xi.

Sydenham mentions dysentery, amongst other diseases, "which commencing in August run on to winter."

In the report upon the status of disease, drawn from returns made at the time of the census of Ireland for the year 1851, Messrs. Donnelly and Wilde conclude that diarrhœa and dysentery prevail more in the summer and autumn than at any other season.

"They occur in the season of summer; next in autumn; less in spring; least of all in winter." — Aretæus, *On the Causes and Symptoms of Chronic Diseases*, book ii. ch. ix.

warm weather advances it gradually declines, and remains low throughout the unusually warm summer, being least prevalent when the mean temperature is highest in July and August. The number of cases begins to rise in the latter end of August, and reaches its maximum on November 28*th*, the mean temperature being then 42°.

During this period, the way in which the two curves of mean temperature and pneumonia supplement one another is very remarkable. From April 11*th* to November 28*th* (thirty-four weeks) there are only seven exceptions to this rule, and when we examine these we find that most of them may be accounted for without much difficulty.

The first of the exceptions occurs in the week ending May 9*th*, when the disease curve rises considerably, the temperature also rising, but it must be remarked that the temperature is still 7° below the average, and that in the preceding week it was 7·5° below the average.

In the week ending May 23*rd* another, but very slight, deviation from our rule may be noticed, — the pneumonia curve continues to descend, while there is a slight fall (half a degree) in the temperature.

In the week ending June 20*th* there is a temporary rise in the number of cases, together with the mean temperature, but this seems again to be accounted for by the occurrence of a temperature 2° below the average in the preceding week.

In the week ending August 29*th* there is a slight rise in the number of cases, which cannot be accounted for by any fall of the mean temperature (68° or 9° above the average). (The N.E. winds prevailed this week, following a long continuance of S.W. winds, and the degree of humidity rapidly fell.)

In the week ending September 26*th* the number of cases diminishes during a falling temperature, but in the preceding week the mean temperature was 5·5° above the

average. Lastly in the week ending November *7th* the onward course of the disease does not seem to be checked by the temporary but unusual heat.

In the spring of 1858 the very close accordance between the two curves is not observed. Although the mean temperature falls lower than it has yet done, and the number of cases of pneumonia is still very great, yet it never again reaches the height that it did in November.

It must, however, be observed that the highest point of the curve this season corresponds with the period of the greatest cold, the week ending March *13th* having a temperature of 35° (6° below the average), the preceding week being still colder (32° or 8·5° below the average). The waves of the disease curve apparently lay behind those of the mean temperature. (The humidity is now diminishing, and N.E. winds very prevalent.)

The mean temperature now begins to rise, and the disease diminishes in prevalence on the whole until August *21st*, many fluctuations intervening, until with the advancing cold of the autumn an increase again takes place.

In the lesser modulations of the two curves from April *10th* to June *26th* (eleven weeks) there is again a very close correspondence, there being only one exception in the week ending May *8th*; the disease curve then falling, after a short rise, while the mean temperature continues to diminish.

From June *26th* to July *24th* there is apparently an important departure from our rule. In the weeks ending June *26th*, July *3rd*, while the mean temperature is falling, the number of cases of pneumonia continues to diminish. It seems probable, however, that this may be owing to the unusual heat of the preceding week (69° or 8·5° above the average), and the discrepancy in July seems to be due to the disease curve rolling up behind that of temperature, the rise in the pneumonia curve following the unusual fall

in the mean temperature of the preceding week (to 6° below the average).

In the week ending August 21*st* the departure from our rule is very slight; the disease curve continues to fall together with the temperature, apparently in consequence of the continued influence of the heat of the preceding week, which is 3·5° above the average.

In the week ending September 18*th* the disease curve rises, and in that ending October 2*nd* it falls in accordance with the curve of temperature, but in the latter instance the preceding high temperature seems to display its influence.

Out of the seventy-nine weeks which we have now examined, twenty-three (29 per cent) exhibit departures from exact accordance with our rule; but, as we have seen, most of these are still to be accounted for on the supposition that the mean temperature influences the progress of the disease; but it seems probable that other elements, such as N.E. winds, also exercise some effect.

Bronchitis and Catarrh.

The curve of these diseases, although drawn from ten times the number of cases, is almost identical with that of pneumonia, its highest and lowest points coinciding exactly with those of the pneumonia curve.

It will be unnecessary, therefore, to trace it throughout its course, since it is evidently affected by temperature in much the same way as pneumonia.

The correspondence of the mean temperature curve with that of bronchitis is even closer than with that of pneumonia, the exceptions being only 26½ per cent.

It may be observed that in the year 1857, when the disease curve marks a deviation from the rule of temperature, it may generally be ascribed to a change in the degree of humidity, the disease curve rising as the amount of moisture diminishes, and *vice versâ*.

The chief discordance between the pneumonia and the catarrh-bronchitis curves takes place in the latter end of September and in October, which may possibly be due to the greater influence of the moisture upon bronchitis and catarrh than upon pneumonia; the degree of humidity at this time rises rapidly.

In June and July 1858, the catarrh-bronchitis curve seems to answer more rapidly to the influence of the temperature than the pneumonia curve does.

Pleurisy.

This disease is too irregular in its course to yield any information in the present investigation, as the meteorological elements under consideration do not appear to have any apparent connexion with it.*

Continued Fever.

It is difficult to trace any connection between the progress of this disease and the meteorological elements under consideration, but on the whole high temperatures seem rather favourable to its production, and extreme cold is probably opposed thereto.

From April 11*th* 1857, the *fever curve*, frequently fluctuating, on the whole ascends until November 7*th*, when a sudden fall takes place, and it sinks rapidly until February 13*th*. In the first part of its course, from May 9*th* to August 29*th*, it accompanies the rise of the mean temperature, but after the latter begins to fall the fever curve goes on rising as steadily as before for two entire months, and is not affected by the advancing cold until the week ending November 14*th*, when the thermometer stands at 45°.

* Among the seasons of the year, winter more especially engenders the disease, next autumn, spring less frequently, but summer most rarely. — Aretæus, *Causes and Symptoms of Acute Diseases*, book i. chap. x.

As though the heat had called into activity some agent which resisted moderate fall of temperature, but which was destroyed by the cold of November, December, and January.*

During the whole time of the gradual increase of the disease the mean temperature is throughout above the average.

From February 1858 the fever curve does not rise much until the week ending June *5th*, when a sudden increase of 110 in the number of cases accompanies a rise of 12° in the mean temperature.

From April *11th* 1858 to October *23rd*, there is the same gradual advance in the disease curve as in the corresponding period of 1857, with the exception of the month of June 1858. The temperature this month was excessive, and to this in a great measure must be attributed the sudden rise in the number of cases. The month of July, which followed, had a temperature considerably below the average, and this checked the rapid advance of the disease for a time; but it will be seen that leaving the month of June out of the question (as being abnormal) the curve gradually ascends up to October *23rd*, when our observations end.

Of the lesser modulations of the fever curve 61 per cent take place in accordance with the variations of the mean temperature, the disease rising and falling with the temperature; and in many of those weeks which present deviations these seem to be due to the lagging of the disease curve behind that of temperature; as in the weeks April 18, 25, May 2, June 6, 13, August 15, 22, 29, and September 5 and 25, 1857; also March 27, May 1, June 26, September 4, 11, 1858.†

* Drs. Donnelly and Wilde remark that fever, although very prevalent in spring, seldom rises to its intensity until summer and autumn.

† It takes birth when spring passes into summer, and it rises towards

Rheumatic Fever.

The curve of this disease is not sufficiently extended to admit of accurate comparison with the meteorological curves, and therefore no decided conclusion can be drawn respecting it.

Our data, however, would bear out the observation of Sydenham: "This disease may come on at any time; it is commonest, however, during the autumn." — *Obs. Med.* vi. 5 (1).

Measles.

In its chief undulations, the measles curve seems to rise with the fall of the temperature, and *vice versâ*; and the influence of this element is best marked when it is above or below the forty-three years' average.

These two propositions will be proved by the following observations.

In the spring 1857 the largest number of cases occurs in the week ending May 2*nd*, when the temperature reaches its minimum (42°) this season, and when moreover it is 7·5° below the forty-three years' average. The disease curve then gradually declines as the temperature rises until August, when there is a sudden temporary increase in the number of cases (of whooping cough also), and a considerable fall from the July temperature, although the latter is still above the average, and remains so throughout the autumn. After this temporary deviation the temperature rises to 68° (7° above the average), and the number of cases diminishes again, but continues to do so for a fortnight after the temperature begins to fall.

From September 12*th* the disease curve rises gradually

maturity as the year advances; with the decline of the year it declines also. Finally the frosts of winter transform the atmosphere into a state unpropitious to its existence. — Sydenham, *Medical Observations*, iii. 2 (5).

while the temperature falls, and it continues to rise until November *7th*, and then falls until November *21st*, as though checked for a time by the temporary rise in the temperature of the preceding week (when it is 8° above the average). The disease attains its maximum in the week ending March *13th*,* the temperature having reached its lowest point in the week preceding, and being moreover 7·5° below the average.

The temperature now rises, and the disease diminishes in prevalence during the month of April: the week ending April *10th* alone has a temperature below the average, and the number of cases again slightly increases for that one week.

During the month of May the disease increases in prevalence, although accompanied by an advancing temperature which, however, is below the average; but after the week ending June *5th*, which has a mean temperature no less than 10° above the average, the disease curve gradually declines until July *10th*. The temperature in the week ending July *10th* sinks to 56° (6° below the average), and from July *24th* to August *7th* it is 2·5° below the average; and in all these instances a slight rise in the number of cases follows. With these exceptions, however, the disease curve rapidly declines until the week ending October *2nd*; this week the temperature sinks to 51° (slightly below the average), and the depression is immediately succeeded by a rapid increase in the number of cases.†

Comparisons of the daily mean barometer readings, during the period April 1857 to October 1858, tend to show that during the time this disease was most prevalent

* "They begin as soon as January; they increase gradually; they reach their height about the *24th* of March; they then gradually decline, so that, with the exception of a few that may attack isolated individuals, they disappear by midsummer." — Sydenham, *Med. Obs.* i. 3.

† Dr. Mühry states that measles in the temperate zone experiences no change with the temperature.

the fluctuations in the atmospheric pressure were far greater than when it was less rife.

Measles seem to be much influenced by the same conditions as whooping cough, since it is usually most prevalent during the same seasons; and yet it is evident that this relation is not exact, since in many of the lesser undulations of the measles-curve the variations take place in the opposite direction to those of whooping cough. (This is the case in twenty-nine out of the seventy-five weeks noticed, about 38 per cent.)

On comparing the curve from April 1857 to March 1858 with the degree of humidity, it seemed that this element had some effect upon the lesser undulations of the disease-curve, since the number of cases rose and fell with the humidity in 72 per cent of the weeks; but on comparing the second period, from April 1858 to October 1858, this hypothesis is not borne out, and the coincidence may be accidental, since in one half the weeks the variations went with the degree of humidity, in the other half they went in the opposite direction. Moreover, although in October, while the degree of humidity is rapidly rising, the disease prevails very greatly, yet in March 1858, when the number of cases reaches its maximum, the degree of humidity is very low; and in September and October 1858, when the relative amount of moisture in the air is the greatest, the number of cases is at its minimum.

Whooping Cough

Seems to be much influenced by the extremes of heat and cold, the curve, on the whole, rising with the fall and sinking with the rise of temperature.

The disease remains apparently unaffected by the gradually increasing warmth of the spring of 1857, but a decided diminution of the number of cases follows as soon as the mean temperature of the week rises to 67°, which takes place in the week ending June 27*th* 1857.

From June 27*th* until October 3*rd* the temperature remains high (above the forty-three years' average nearly every week), and during this time the disease is at its minimum (between forty and fifty cases per week).

The number of cases does not again increase until the sudden fall of temperature in October and November, after which the weekly average remains pretty constant until February 13*th*, unaffected by the great fall of temperature in the week ending January 9*th* 1858, but it again rises rapidly after the extreme cold of February and March (which was much below the forty-three years average).

It remains very prevalent during the spring of 1858, but the remarkably warm June appears to check its progress, just as it did in the preceding year.

It is important also to notice that an increase in the number of cases again takes place in July, the temperature being much below the average; the year before the curve declined much more regularly and continuously.

During the summer of 1858 the disease remains almost stationary, as in the preceding year; but while it may be observed that the temperature is never so high as then, the number of cases never sinks so low (seldom below sixty).*

Scarlatina.

A large amount of aqueous vapour in the air appears greatly to facilitate the formation and action of the peculiar scarlatinal poison, especially when this is accompanied by sudden fluctuations in the atmospheric pressure as shown by the barometer; a diminished pressure being favourable to the disease.

It is rather difficult to separate the influence of tempera-

* Drs. Donnelly and Wilde remark that spring affords rather more than the average amount of small pox, measles, scarlatina, and whooping cough. *Census of Ireland for* 1851.

ture from that of humidity, but a moderately low temperature seems to be favourable to the progress of the disease, whilst the extremes of both heat and cold seem often to exert a disturbing influence one way or the other; a temperature above the average generally diminishing, cold increasing the number of cases.

From May *9th* to August *8th* 1857, the degree of humidity remains low (below 0·7), although fluctuating considerably, and the number of cases is small; but in the lesser fluctuations the two curves rise and fall together in a remarkable manner. In the seventeen weeks from April 11 to August 8 1857, there are only three exceptions to this observation; the first two exceptions occur together in the weeks ending May *23rd* and *30th*, the number of cases increasing while the degree of humidity falls, and it may be noticed that the first decided rise in the temperature occurs in the preceding week; the mean temperature then rose from 45° to 56°, and during that week and the next it remained nearly 6° above the average — the barometer regularly descending for three weeks.

The second exception is in the week ending June *27th*, and at this time again the perturbing influence of heat seems to act, the mean temperature rises 7°, and is 7° above the average. The humidity increases, and the barometer goes down, but the number of cases diminishes.

On July *18th* the scarlatina-curve begins to rise, and on the whole continues to do so until October *31st*, thus accompanying very closely the degree of humidity; but in the week ending August *29th* there is a sudden fall both in the degree of humidity and in the number of cases, the mean temperature being very high (68°) and 7° above the average.

From August *29th* there is a steady rise in the number of cases until October *3rd*, but the following week a slight

fall occurs, and it may be noticed that in the two preceding weeks there has also been a slight fall in the degree of humidity, and in the week ending October 10*th* there is a great diminution of atmospheric pressure (barometer 29·4^{ms}, the lowest this year), and this is at once followed by a further rise in the degree of humidity and the number of cases.

From October 10*th* until November 21*st*, both the curves remain high, but in their secondary undulations, instead of being in accord, they supplement one another.

In the week ending November 14*th*, the highest degree of humidity accompanies a decline in the disease curve, but is followed in the week after by an increase in the number of cases. The two curves then decline on the whole until December 5*th*, when the returns of disease are discontinued for six weeks.

In the spring of 1858 the degree of humidity remains tolerably high, without any great prevalence of the disease; but here again may be noticed for twelve weeks an almost exact accord between the rise and fall of the secondary waves of the two curves. There are two exceptions to this rule: First, in the week ending March 6, the number of cases continues to fall after the sudden depression of the degree of humidity has ceased. In this week the atmospheric pressure is again very small (29·6^{ms}), and the week following there is again a sudden rise in both the disease and the humidity curve.

In the week ending March 20*th* there is no material change in the degree of humidity, but the mean temperature rises 13°, and is 6° above the average, and the scarlatina-curve descends again.

During April the number of cases diminishes gradually, and on the whole the humidity-curve declines, but fluctuates remarkably, the scarlatina-curve marking these fluctuations by slighter variations in accordance with them.

An apparent exception to the rule which we have hitherto noted now takes place. From May 8*th* the disease-curve begins on the whole to rise, while the degree of humidity with great fluctuations seems to descend until the middle of June (as in the preceding year the secondary undulations corresponding with those of the disease). At the same time, however, it must be noticed that the mean temperature in the beginning of May is very low (46° or 6° below the average), and it does not rise materially until the week ending June 5.

For a fortnight after this date the temperature rises, and remains very high (66°), nearly 10° above the average, while the number of cases diminishes during the same time.

From June 26*th* the humidity and disease curves on the whole rise until October 23; but from July 10 to July 24 the degree of humidity falls as the disease curve rises; and here again we may perhaps trace the disturbing influence of temperature, the week ending July 10*th* having a a mean temperature of 56·5° (6° below the average).

In the week ending August 7*th* the disease-curve rises very rapidly (sixty cases), while the degree of humidity remains low; but the preceding week the mean temperature has been 2·5° below the average.

During the four following weeks the variations in temperature would seem to have the chief influence upon the disease, the rise and fall of the fluctuations of temperature and scarlatina supplementing one another very closely.

In the week ending September 4, the barometer is very low, and the following week the degree of humidity rises considerably, while the temperature remains stationary, but there is a rapid rise in the disease curve.

The number of cases again falls greatly in the week ending September 18, probably from the action of the unusual heat, the temperature rising to 63·5° (6·5° above

the average), while the degree of humidity continues to rise.

From this time, however, until October 16*th*, the humidity again appears to exert its influence, and the curves are in accordance.

The disease curve reaches its highest point for the year (200 cases) in the week ending October 16*th*, the degree of humidity rising rapidly until October 23*rd*, but the temperature not descending much, and remaining 2° above the average.

It is interesting to observe the manner in which the curve of scarlatina supplements the curves of whooping cough and measles. "Thus they vex humanity by turns, as the constitution of the year and the sensible temperature of the air most assist the one or the other." — Sydenham.*

In the foregoing examination into the effects of the several meteorological elements upon scarlatina, it will be seen that we have ascribed to humidity the chief influence, but at the same time have carefully noted the effects of variations of temperature and pressure of the atmosphere; but it may be that we have not sufficiently indicated the reasons for our opinion.

Without very close comparison it would be very difficult to decide whether temperature or humidity had the greatest influence upon this disease. First, if we take the correspondence of the curves during the same times, we shall find that in 64 per cent of the weekly periods the number of cases rose and fell with the fall and rise of the thermometer, and in 63 per cent with the rise and fall of the degree of humidity; in 42 per cent of the periods

* Sydenham states that scarlet fever may appear at any season, but oftenest towards the end of summer. — *Med. Obs.* vi. 2, 1. He also speaks of one epidemic being driven out by another "ut clavum a clavo." — *Med. Obs.* ix. 1, 7.

these two elements might act together, the temperature falling as the degree of humidity and disease-curve rise, and *vice versâ*. Of the weeks in which the degree of humidity and temperature rise and fall together, the apparent effects, as shown in the rise and fall of the disease-curve, are almost exactly balanced, there being fifteen points of agreement with the temperature, sixteen with the humidity-curve. The fact of accordance between the rise and fall of the curves, however, must be of little importance in determining the influence of the element upon the disease, compared with observations upon the *actual state* of the air at the time of prevalence or absence of the disease.

A few instances will, we think, show that the temperature, although by no means inactive, exerts less influence than the humidity.

While the degree of humidity is at its lowest point in 1857, between June 6 and July 18, the number of cases is also the least, scarcely rising above thirty. During the corresponding period in 1858, between April 1 and July 10, although the disease is rather more prevalent than in the year before, yet the number of cases rarely exceeds fifty, and does not increase until the degree of humidity begins on the whole to rise.

Both in 1857 and 1858, when the amount of moisture in the air is greatest, the disease-curve is at its highest point.

On the other hand, a low degree of temperature accompanies both the smallest and largest number of cases in both 1857 and 1858, and the same is true of a high temperature; *e.g.* on July 18, 1857, the mean temperature is 68° while the disease is at twenty-five, and in August 1858, with the mean temperature above 60°, the number of cases remains above 100. Notwithstanding this remark, however, many of our observations will prove that temperature has an important modifying action.

Thus far has our investigation carried us. We already trace, though often but faintly, the influence of the few meteorological elements which we have studied. Taken in connection with large numbers of cases of disease, although a clearly defined and exact accordance cannot be found, still we perceive a certain general relation existing between them, and enough may perhaps have been done to prove the value of such an inquiry. The returns for several of the weeks, especially those ending August 22*nd* and 29*th*, 1857, and March 6*th*, 1858, are very imperfect; but after careful examination we do not find that these deficiencies affect the conclusions at which we have arrived. In each instance, when appreciable, the probable amount of error arising from this source had been marked in pencil upon the chart.

Before closing this paper we must state that it seems very desirable that many other branches of meteorological research should be included in the inquiry, and compared with disease; among these may be mentioned winds, electricity of the atmosphere, rain, microscopical and chemical analyses of the atmosphere. Under the last-named head regular series of observations, made at various stations with the sepometer of Dr. R. A. Smith, F.R.S., would be of very great importance.

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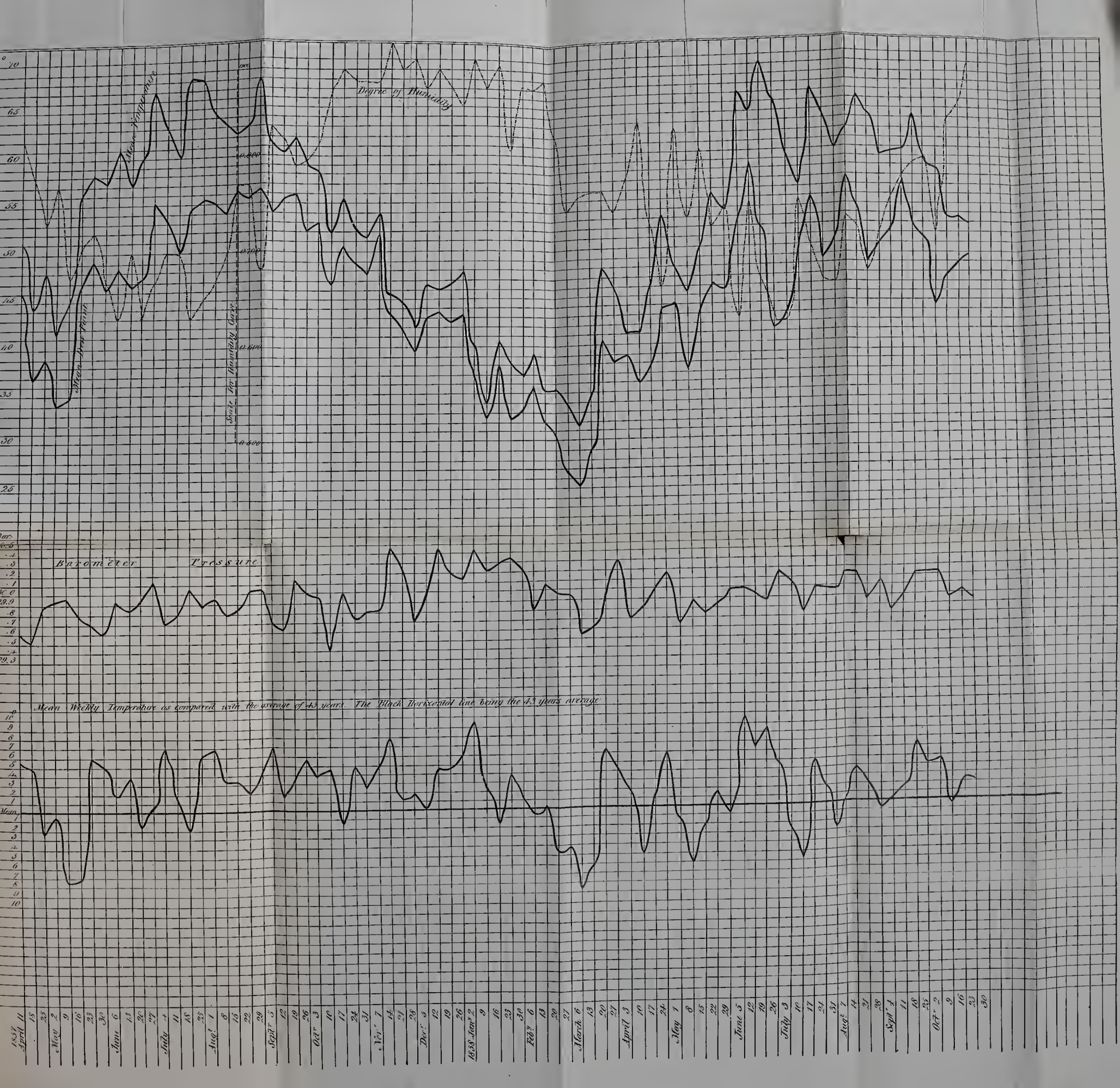
Mean Temperature
Degree of Humidity
Mean Low Point
Scale for Humidity Curve
Barometer Pressure
Mean Weekly Temperature as compared with the average of 43 years. The Black Horizontal line being the 43 years average


1857 Weeks ending
April May June July August September October November December
1858 January February March April May June July August September October
Whooping Cough
Measles
Scarlatina
Pneumonia
Bronchitis and Catarrh
Continued Fever
Rheumatic Fever
Diarrhœa
Dysentery
Pleurisy
Scarlatina Scale